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Original Research

Time trend analyses of child pedestrian morbidity in Japan

S. Nakahara ^{a,*}, M. Ichikawa ^b, T. Sakamoto ^a^a Department of Emergency Medicine, Teikyo University School of Medicine, 2-11-1 Kaga, Itabashi, Tokyo, 173-8606, Japan^b Department of Global Public Health, Faculty of Medicine, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki, 305-8577, Japan

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ABSTRACT

Objectives: Road traffic injuries, particularly pedestrian injuries, are a major health issue among children worldwide. The present study quantitatively analyzed the time trends of child pedestrian injuries in Japan from 1975 to 2013 by age.

Study design: Time trend analysis of nationally aggregated data.

Methods: We analyzed police data on pedestrian injuries requiring medical treatment among children aged 0–15 years occurring between 1975 and 2013. To quantify the time trends of pedestrian injury morbidity rates and to identify change-points in the trends, joinpoint regression analysis was applied by age group. Children were categorized into the age groups of 0–3, 4–6, 7–9, 10–12, and 13–15 years old.

Results: Preschool children aged 0–6 years old showed continuous declining trends throughout the study period; these declining trends accelerated in the 2000s. School-age children aged 7–15 years old showed minimal changes from the early 1970s to the 1990s; of this age group, children aged 7–12 years old showed slight but significant declining trends in the first half and increasing trends in the latter half of this period. Children aged 7–15 years old showed declining trends in the 2000s. Despite the consistent declining trends among all age groups in the 2000s, the younger age groups showed steeper declines during this period.

Conclusions: The declining trends in all age groups in the 2000s may reflect the improved traffic environments in Japan although the environmental approaches are not yet sufficiently adopted yielding modest effects. The continuing contrast between preschool and school-age children may reflect different behaviour changes by age such as more restricted outdoor activities among young children.

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* Corresponding author.

E-mail address: snakahara-tyk@umin.net (S. Nakahara).<http://dx.doi.org/10.1016/j.puhe.2016.08.014>

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Introduction

Road traffic injuries are a major worldwide health issue.¹ Mortality and morbidity, while decreasing in high-income countries, are increasing in low- and middle-income countries because of rapid motorization and insufficient countermeasures.² The most recent United Nations' Sustainable Development Goal has included a 50% reduction in road traffic mortality and morbidity by the year 2020 as a health-related target.³

In the early phase of motorization, child pedestrians are particularly at high risk of injury in areas where pedestrian protection is insufficient, which used to be seen in the past in high-income countries and is currently seen in low- and middle-income countries.^{1,2,4} As a nation's economy develops, traffic management and control improves and traffic behaviours of drivers and pedestrians alike become adaptive. Thus, the initial increasing trends towards traffic injuries peak and consequently begin to decline.⁵ Lessons from the experiences and success in this later phase of the current high-income countries can facilitate pedestrian safety in countries still in the early phase of motorization.

Whereas many high-income countries share decreasing trends in traffic injuries, including child pedestrian injuries, these decreasing trends and their attributable factors vary with time, place, and child age.^{6–12} Major contributing factors include reduced walking distance and improved roadway and walkway conditions, both of which reduce exposure to traffic. However, the effectiveness of safety education remains uncertain.¹³ Countries emphasizing improvements of traffic environments show steeper declines in traffic injuries than those countries emphasizing safety education.⁹

In Japan, the pedestrian mortality and morbidity of children <15 years old peaked in 1970 at 6.5 and 301.5 per 100,000 children, respectively. By 2013, mortality and morbidity had decreased to 0.35 and 62.1, respectively.^{14,15} The declining trends differed with time between the different age groups. Our previous study of child pedestrian injuries in Japan^{11,12} described consistent declining trends regardless of age in the early 1970s, which can most probably be attributable to improved traffic environments. We also attributed different trends in preschool and school-age children between the late 1970s to the 1990s (declining morbidity rates among preschool children and constant morbidity rates in school-age children) to different traffic behaviours. The aim of the present study was to examine child pedestrian morbidity trends in Japan in the 2000s by age group and to reexamine the trends from the late 1970s to the 1990s using a quantitative time series method.

Methods

Study design

The present study retrospectively analyzed the time trends of pedestrian injuries among children aged 0–15 years between 1975 and 2013. To identify increasing or decreasing trends and trend changes in age-specific pedestrian morbidity rates, we

applied a joinpoint regression model to nationally aggregated data. Ethical clearance was not required for the present study which used nationally aggregated population data.

Data

We obtained age-specific data on fatal and non-fatal road traffic injuries from Traffic Accident Statistics collected by the National Police Agency and compiled by the Institute for Traffic Accident Research and Data Analysis.¹⁶ The data included information regarding injured victims who required medical treatment. The attending police officers collected nationwide crash data using a standardized format. We obtained data regarding an age-specific population from the Ministry of Internal Affairs and Communications including census data for quinquennial census years and population estimates for intercensus years.^{17,18}

Analyses

Initially, we indicated the age-specific 5-year average morbidity rates from 1975 (data from 1973 to 1977 were averaged) to 2010 (data from 2008 to 2012 were averaged) quinquennially to visualize the differences in smoothed morbidity changes by age. The numerator was the 5-year sum of injured children, and the denominator was the 5-year sum of population (i.e. 5-year average of number of injuries was divide by the 5-year average of population). Data for those aged 16–19 years old were shown for reference given that their injury patterns were similar to those of adults.

We then conducted trend analyses for the years 1975–2013 in children categorized into 0–3, 4–6, 7–9, 10–12, and 13–15 years old age groups. This categorization roughly corresponds to school attendance and outdoor activities: children aged 0–3 years seldom go outside alone, those aged 4–6 years attend kindergarten, those aged 7–12 attend primary school (independent outdoor activities of lower graders are restricted), and those aged 13–15 attend middle school. The trends prior to 1975 were not included in the analyses because morbidity and mortality rates in all age groups showed a similar pattern during this period: an increase in the 1960s, a peak in 1970, and a decrease in the early 1970s.^{11,12} This is because multifaceted measures were initiated in the early 1970s in response to increasing road traffic injuries in the 1960s. These measures were effective for all age groups, but rapidly increasing traffic volume overwhelmed these measures in the late 1970s. Since then, the trends began to differ by age, which came about from varying effectiveness of subsequent targeted measures and the influence of behavioural changes.

The trend analyses used joinpoint regression models with the morbidity rates in each year as the dependent variable and the time period as the independent variable. The joinpoint regression analyses fit several trend segments (regression lines) to the data.¹⁹ If adjacent trends differed (trend change), the meeting point was determined as a change-point (joinpoint). Thus, the joinpoint regression analyses can determine whether there is an increasing or decreasing trend in each segment, whether there are any trend changes, and, if so, how many changes. This method is appropriate to describe trends and trend changes.

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